Stratix Switches Within Integrated Architecture

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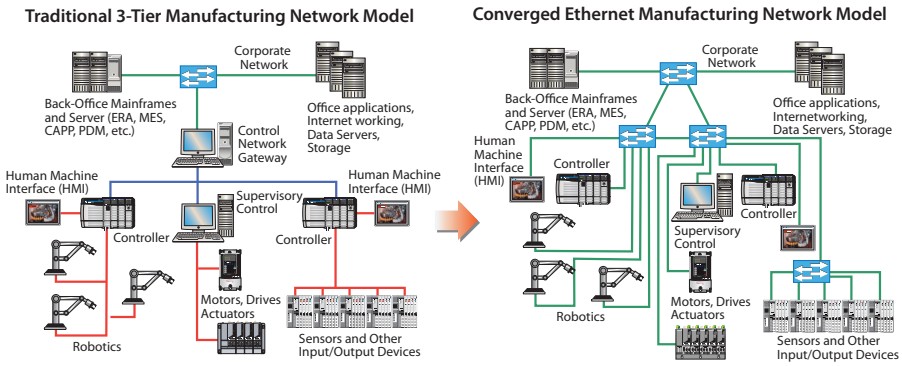
Synopsis

Industry adoption of EtherNet/IP™ for control and information has driven the wide deployment of standard Ethernet within manufacturing. This adoption triggered migration from the traditional three-tier manufacturing network model to a converged Ethernet manufacturing network model, as shown in Figure 1. Although Ethernet has been a technology driver behind the convergence, it was business facets such as lowering the total cost of ownership, implementation of lean initiatives and better asset utilization that drove this migration.

Figure 1
EtherNet/IP Enables the Migration to Converged Ethernet



The converged Ethernet model introduces active components, such as switches, into the manufacturing network infrastructure. These active components traditionally required separate management tools and were not integrated into the control system itself. This disconnect from the control system can lead to higher asset management costs, longer mean time to repair (MTTR) and lower overall equipment effectiveness (OEE), which undermines the business drivers that drove the migration in the first place.

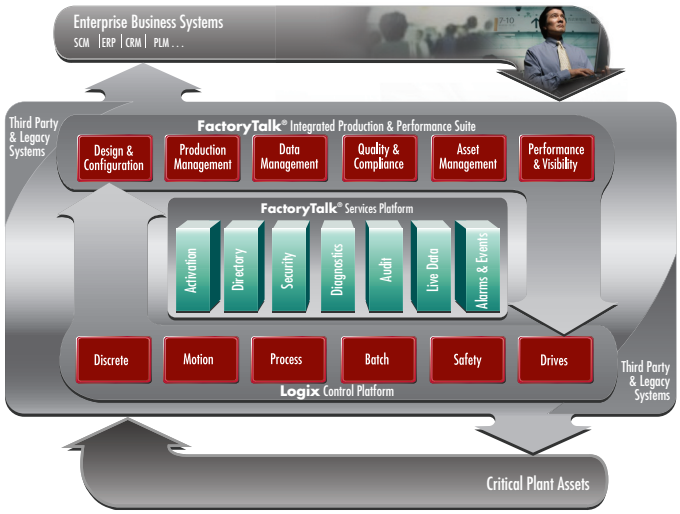
This whitepaper outlines the Rockwell Automation Stratix family of managed switches highlighting integration into the Rockwell Automation Integrated Architecture™. This premier integration delivers the technology that enables the converged Ethernet network model in response to business drivers. At the end of this whitepaper is a listing of additional reference material; See Reference 1 for additional information on the converged Ethernet manufacturing network model.

Using EtherNet/IP in your Integrated Architecture

To help lower costs, implement lean initiatives and utilize assets more effectively, manufacturers have integrated disparate production control systems – or islands of automation – into a plantwide control and information system utilizing a common platform. This platform is the Rockwell Automation Integrated Architecture. The integrated architecture consists of the Logix programmable automation controllers (PACs) and the FactoryTalk® Integrated Production and Performance Suite. EtherNet/IP is the backbone for this control and information

platform, delivering multidiscipline applications of batch, continuous process, safety, motion, drive and discrete control, see Figure 2. For additional information on Integrated Architecture, see Reference 2.

Figure 2
The Rockwell Automation Integrated Architecture



EtherNet/IP is an industrial automation network specification maintained by the ODVA vendor association. EtherNet/IP uses the Common Industrial Protocol (CIP™) for its application layer, while using standard TCP/UDP/IP for the transport/network layers. CIP provides multidisciplined industrial networking for control, information, safety communication, time synchronization, and motion control through the network extensions CIP Safety™, CIP Sync™ and CIP Motion™. For additional information on EtherNet/IP, see Reference 3.

The Integrated Architecture can maximize asset utilization by reducing maintenance, repair and operational (MRO) inventory, while providing common application development tools that minimize the need for specialized knowledge and expertise on the part of engineers, operators and maintenance. As a core extension to the Integrated Architecture control and information platform, Stratix managed switches further minimze MRO while maximizing human assets by utilizing common Integrated Architecture development tools.

Converged Ethernet Model

As manufacturing network technologies converge, the network models do not necessarily flatten. Manufacturing assets are no longer isolated within the manufacturing realm, and are now susceptible to the same security vulnerabilities as their enterprise counterparts. Deploying a robust and secure network infrastructure requires protecting the integrity, availability and confidentiality of control and information data. For additional information on network security, see Reference 6, 7, 8 and 9.

Managed switches with advanced services are required to manage network traffic for today's multidiscipline control applications:

- Virtual LANs (VLANs) for network segmentation – manage traffic, contain broadcast/multicast traffic and establish domains of trust
- Quality of Service (QoS) for traffic prioritization – give preferential treatment to control traffic
- Resiliency protocols – ensure availability of data
- Multicast management
- Security
- Diagnostics

The Stratix managed switches are uniquely designed to integrate network infrastructure health status into the control system. This provides diagnostics to operations and maintenance that are consistent with the rest of the control system. Thus increasing the overall asset utilization by minimizing the need for specialized training. These benefits, in addition to having common development tools, lowers the total cost of ownership.

Stratix Ethernet Switch Overview

To effectively manage real-time control and information within the converged Ethernet architecture, Rockwell Automation offers the following portfolio of managed industrial Ethernet switches:

- Stratix 6000™ fixed configuration
- Stratix 8000™ modular configuration
- Embedded switch technology – switch technology directly embedded into end devices for linear and ring network topologies

This portfolio provides settings that are optimized for use in EtherNet/IP applications, as well as the network services noted above. For additional information on Stratix Ethernet switches, see Reference 4.

The Stratix 6000 fixed-managed switch and the Stratix 8000 modular-managed switch have a built-in EtherNet/IP (CIP) interface. This interface allows these switches to share real-time network configuration and health status information with the Logix PAC™s. These switches appear as standard I/O devices seamlessly integrating into Logix programs and using predefined tags. This provides for continuous network monitoring such as traffic overloads, port status and unauthorized access detection.

Common Stratix 6000 and Stratix 8000 features:

- CIP objects – switch configuration, management and diagnostics accessible within common Integrated Architecture software tools – decreasing MTTR and training requirements, thus increasing asset utilization.
- RSLogix™ 5000 software Add-on Profile (AOP) – premier integration into Logix PACs and the Integrated Architecture.
- Predefined Logix Tags – rich set of predefined structured tags for programmatic and HMI use such as switch status and enabling and disabling ports.
- FactoryTalk® View Faceplates – Machine Edition (ME) and Site Edition (SE) faceplates for switch status and alarming.
- IGMP Snooping and Querier – multicast traffic management.
- Port security.
- DHCP per port – reduce MTTR by automatically assigning the same IP addresses to replacement devices based on the port they are plugged into.

Advanced Stratix 8000 features:

- Cisco Catalyst® operating system – IT feature set with command line interface (CLI) and Cisco Network Assistant (CNA).
- Resiliency – Rapid Spanning Tree Protocol (RSTP), Resilient Ethernet Protocol (REP), and EtherChannel (port aggregation).
- Removable compactflash card – switch configuration and operating system – simplifies replacement reducing MTTR.
- As part of AOP, the switch configuration is also stored as part of RSLogix 5000 project file.
- Quality of Service (QoS) – specifications per ODVA for EtherNet/IP
- Virtual LAN (VLAN) – 802.1Q VLAN Trunking.
- Security – access control lists (ACL), 802.1x.
- Layer 3 routing (Stratix 8300 only) – capability to route between VLANS and subnets.

Integration of controls and network infrastructure supports technology convergence while maintaining the desired business aspects of reducing total cost of ownership by reducing asset costs, decreasing MTTR, and increasing OEE.

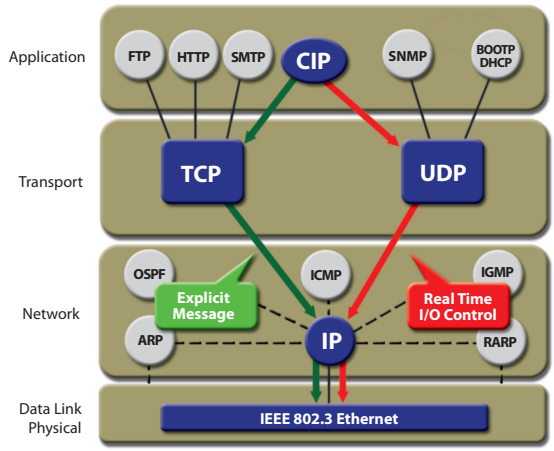
Although the Stratix 6000 and Stratix 8000 have similar CIP capabilities, only those of the Stratix 8000 are used throughout the rest of this whitepaper to illustrate the premier integration of Stratix into the Integrated Architecture.

Common Industrial Protocol

The Common Industrial Protocol (CIP), managed by the ODVA, is an application layer protocol that provides seamless plantwide communication for I/O control, device configuration and data collection. For additional information about CIP and ODVA, see Reference 5.

CIP is a connection based protocol which uses abstract object modeling to describe the suite of available communication services for an EtherNet/IP device. CIP supports two basic types of messaging: explicit messaging and implicit messaging (commonly called I/O Messaging). See Figure 3.

Figure 3
EtherNet/IP Implicit and Explicit Messaging



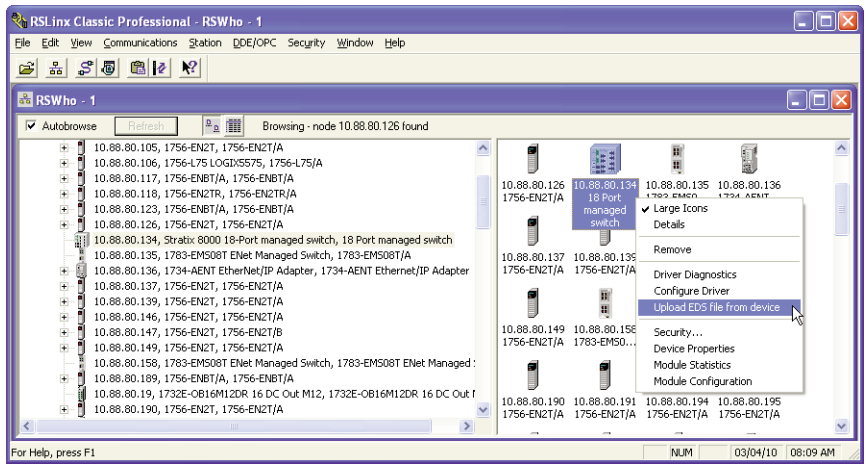
Explicit messaging connections provide generic, multi-purpose communication paths between two devices. These connections are often referred to as messaging connections. Explicit messages provide request/response-oriented network communication. Each request is typically directed at a different data item. Message instructions within a Logix PAC are an example of explicit messaging. Explicit messages also are used for configuring, monitoring and troubleshooting the Stratix managed switch. For example, the RSLogix 5000 AOP uses the explicit messaging interface to configure the Stratix 8000.

Implicit (I/O) connections provide dedicated, special purpose communication paths between a producing application (I/O device) and one or more consuming applications (e.g. PAC). The application-specific I/O data that moves through these connections is a fixed structure and is typically exchanged cyclically. Logix PACs communicate to EtherNet/IP devices, including the Stratix 8000 switch, identified within the I/O tree of RSLogix 5000 via implicit (I/O connection) messaging. Stratix 8000, with its CIP objects, appears to Logix PACs in the same manner as any other Rockwell Automation EtherNet/IP device such as an I/O block or PowerFlex drives.

EtherNet/IP devices have electronic data sheets (EDS). These are specially formatted text files, as defined by the CIP Specifications, which represent the object model of the device. EDS files contain details about the readable and configurable parameters of the EtherNet/IP device. They also provide

information about the I/O connections the device supports and the content of the associated data structures. EDS are used by EtherNet/IP device configuration tools, such as RSNetWorx™ for EtherNet/IP, and data servers such as RSLinx™ Classic.

Figure 4
RSLinx Classic
Stratix 8000 EDS



RSLinx Classic, see Figure 4, is a communication server providing plant-floor device connectivity for a wide variety of Rockwell Automation software applications such as RSLogix 5000 and FactoryTalk® View Site Edition. RSLinx Classic provides a user-friendly graphical interface for navigating through the CIP networks. The Stratix 8000 supports RSLinx Classic functions similiar to other EtherNet/IP devices.

With RSWho, the graphical navigation interface of RSLinx, EtherNet/IP networks can be easily browsed to locate and identify EtherNet/IP devices, such as the Stratix 8000 switch. As shown in Figure 4, selecting then right-clicking on the Stratix switch will bring up a device menu presenting several options. For example, selecting device properties will show specific identity information such as vendor name, product code, revision and serial number.

EDS files for the Stratix 8000 switches are included with RSLinx Classic, RSLogix 5000 and RSNetWorx for EtherNet/IP software packages. EDS files can also be accessed by:

- Downloading the required EDS files from the Rockwell Automation web site, see Reference 10 and 11.
- Uploading the EDS files directly from the Stratix 8000, see Figure 4.

Stratix Premier Integration

RSLogix 5000 software allows for several different profile types that connect devices to the control system, ranging from basic (generic profile) to highly custom (specific profiles). The generic profile provides minimal connectivity to Logix in a basic general purpose format, see Figure 5. The Stratix 8000 profile is a specific profile that provides premier integration to the Logix PAC and the rest of the Integrated Architecture, see Figure 6. This profile sets Stratix 8000 apart from other CIP-enabled switches which use a generic profile.

Figure 5
Generic Ethernet Module Profile

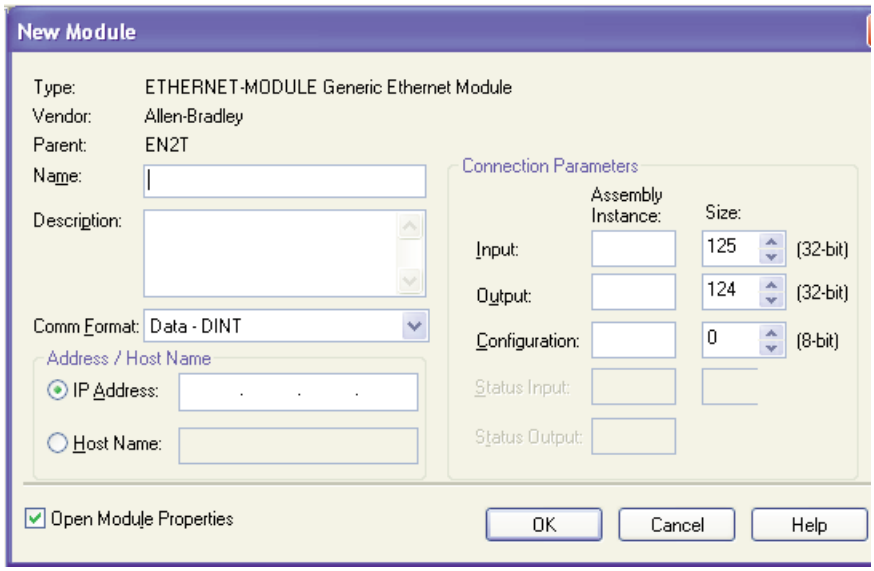
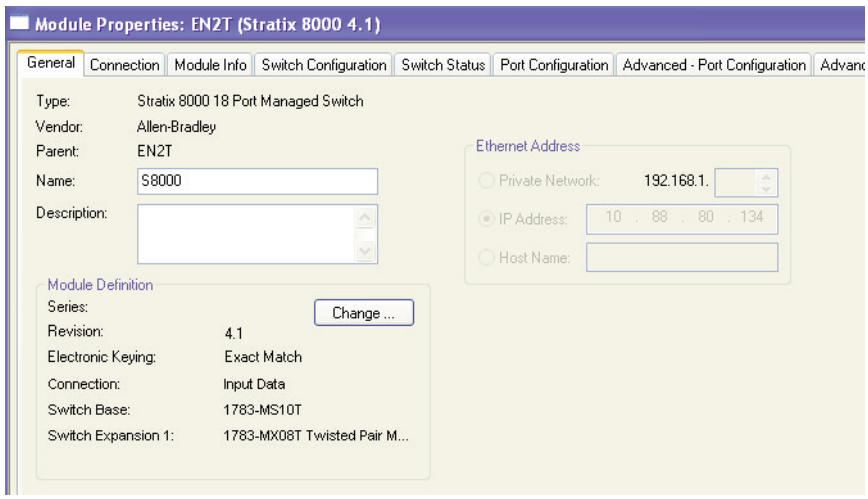
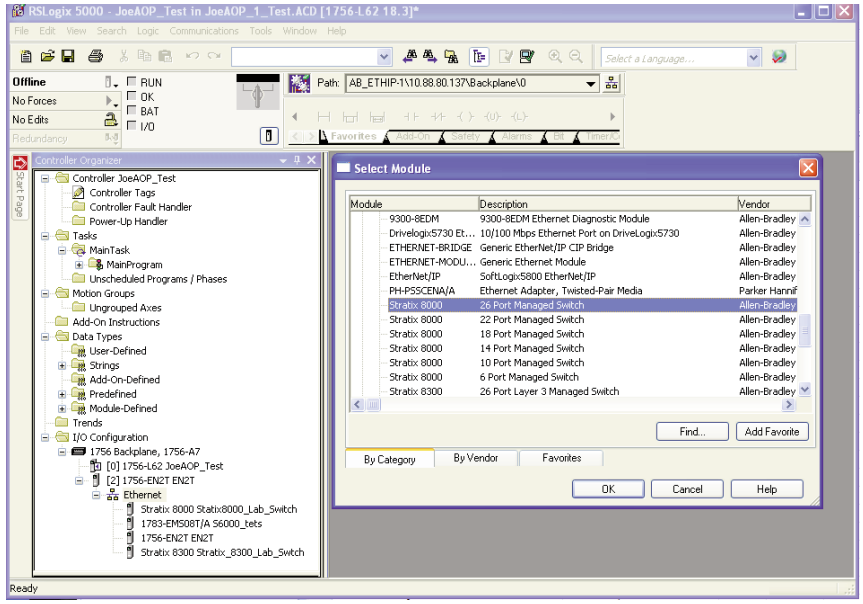


Figure 6
Logix 5000 Stratix 8000 Profile



The Stratix profile provides device-specific user friendly configuration dialogs and monitoring screens. It also provides the detailed data (tags) and communication structures for use by the controller program. Premier integration in Integrated Architecture allows you to select a specific Stratix 8000 switch from a list, see Figure 7, rather than a nondescript Generic Ethernet Module. Following selection, the profile provides the ability to easily add the Stratix switch as part of a Logix PAC project by following the same procedure as any other EtherNet/IP device with a predefined profile. This further extends the ability of the control engineer to use a single known configuration tool to manage a project.

Figure 7
RSLogix 5000
Stratix 8000 Profile
Selection

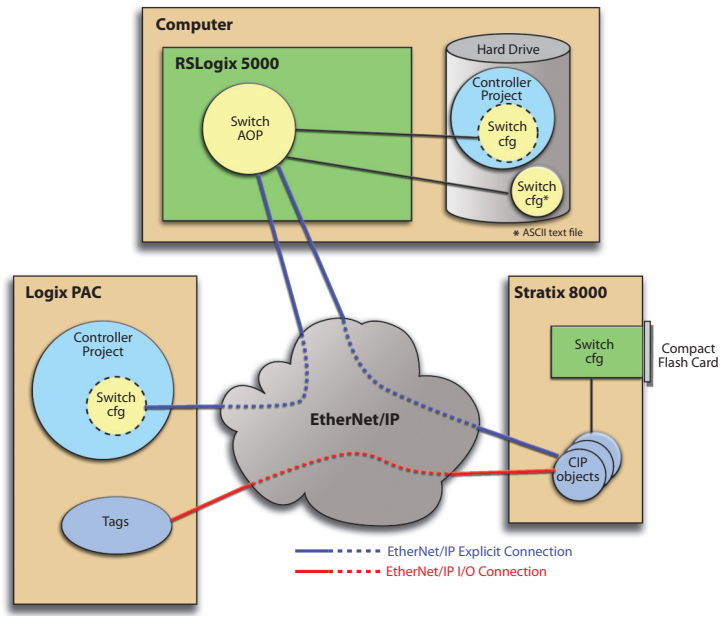


Once added to the Logix PAC project, the Stratix 8000 profile provides four major capabilities:

- I/O connection between the Stratix 8000 and the Logix PAC with predefined tags.
- Configuration of the Stratix 8000 configuration as part of RSLogix 5000.
- Save and Restore of the Stratix 8000 configuration as part of the RSLogix 5000 project.
- Monitoring and troubleshooting the Stratix 8000 status through predefined tags and user-friendly RSLogix 5000 screens.

These major elements and their communication relationships are shown in Figure 8.

Figure 8
Stratix 8000 Profile
Communications Model



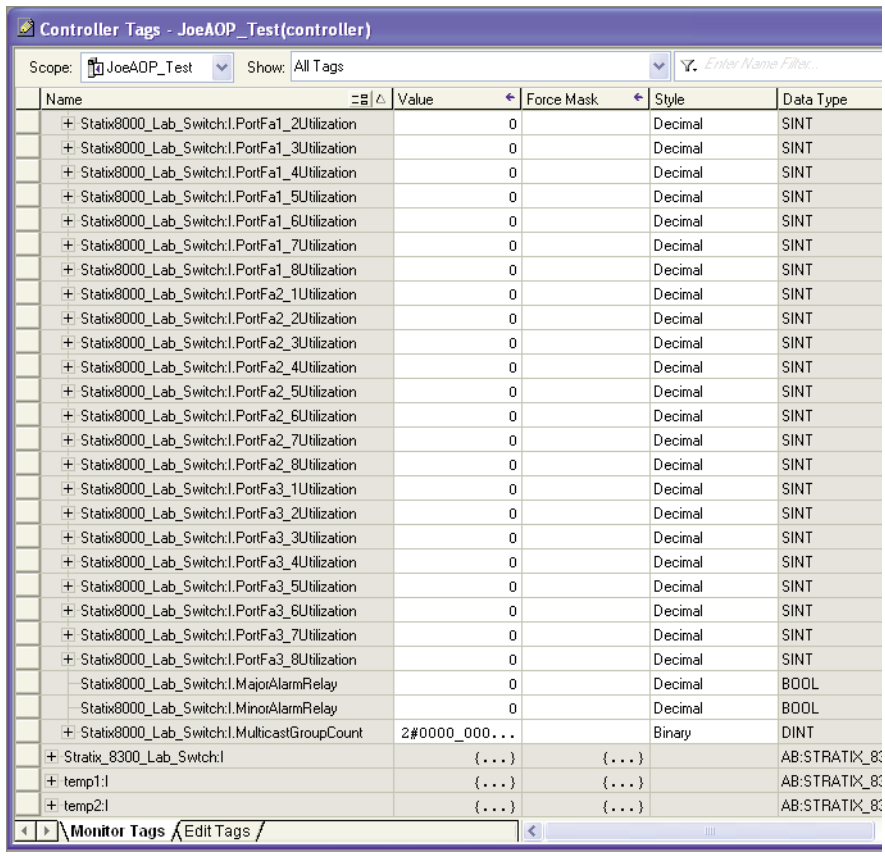
I/O Connection

The I/O connection provides the capability to automatically pass status and control data between the Stratix switch and Logix PAC. Status information can also be shared with multiple Logix PACs via multicast communication. Once added to a project, predefined logic tags, as shown in Figure 9, are automatically created in the Logix PAC for programmatic use and HMI access. This data includes overall Stratix switch status and specific port status such as:

- Communication faults
- Link status
- Security - unauthorized user MAC ID
- Threshold limits exceeded
- Bandwidth utilization
- Major and minor alarm status
- Number of active multicast groups

The Stratix 8000 I/O connection includes the input data, partial listing shown in Figure 9, plus the capability to enable or disable specific ports on the Stratix 8000 from the Logix PAC. This capability allows the logic programmer to conditionally turn Stratix 8000 ports on or off. For example, a user can deny or grant access to a Stratix switch port based on the state of the machine or process at a specific time of day. Predefined, self-described Stratix 8000 tags simplify usage within Logix PACs and help reduce troubleshooting time.

Figure 9
Stratix 8000
Predefined Tag Structure



Configuring the Stratix Switch

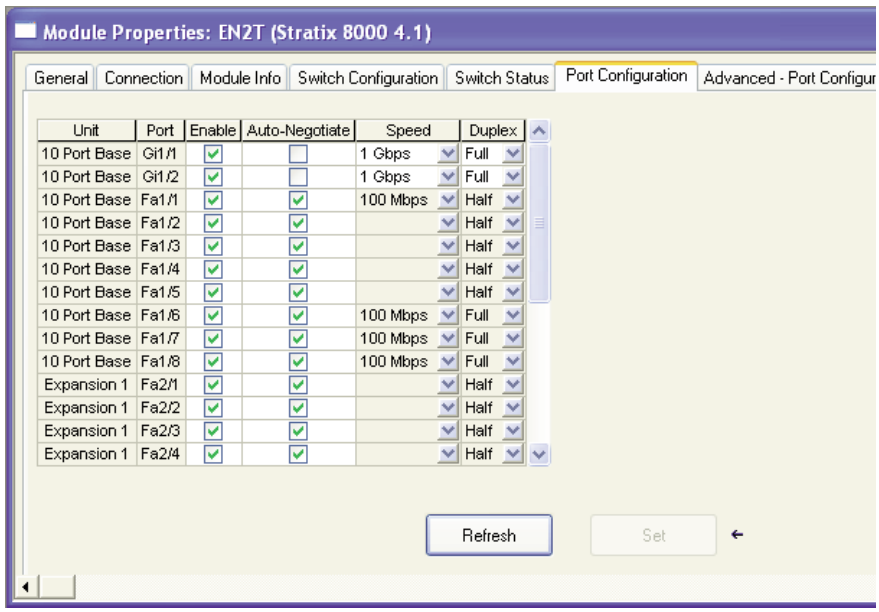
The RSLogix 5000 add-on profile (AOP) allows for configuration of important Stratix 8000 parameters. Within the AOP configuration, numerous tabs allow the user to configure general Stratix 8000 parameters and port specific parameters. Any configuration changes are automatically saved to the compact flash card within the Stratix 8000 switch.

Parameters which are configurable include:

- IP Address and Subnet Mask
- Location and Contact Information
- Port Enable/Disable
- Speed, Duplex, Autonegotiate
- Smart Port Selection and VLAN assignment
- Authorized MAC ID
- Threshold settings
- IEEE 1588 Precision Time Protocol (CIP Sync)
- DHCP per port settings

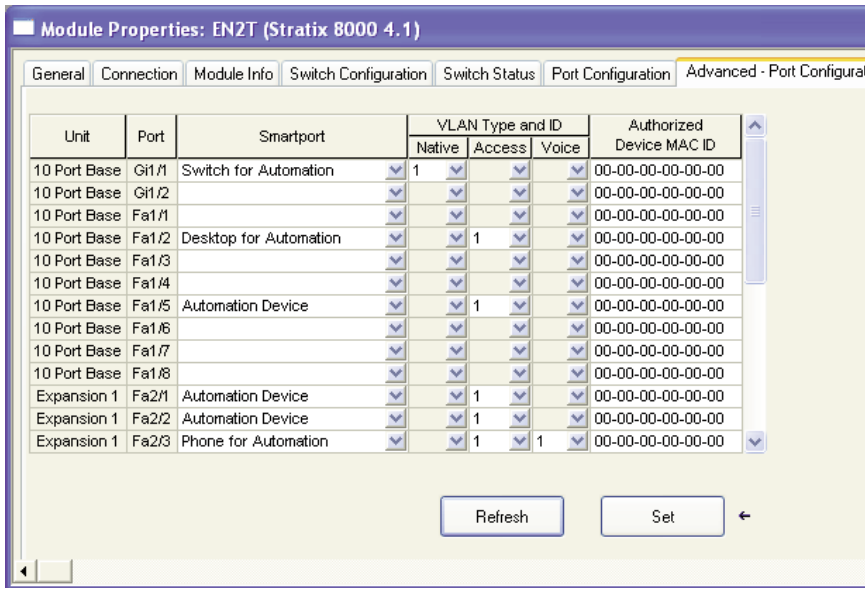
The port configuration tab allows configuration of common attributes on a port-by-port basis, see Figure 10.

Figure 10
Stratix 8000 Profile
Port Configuration Tab



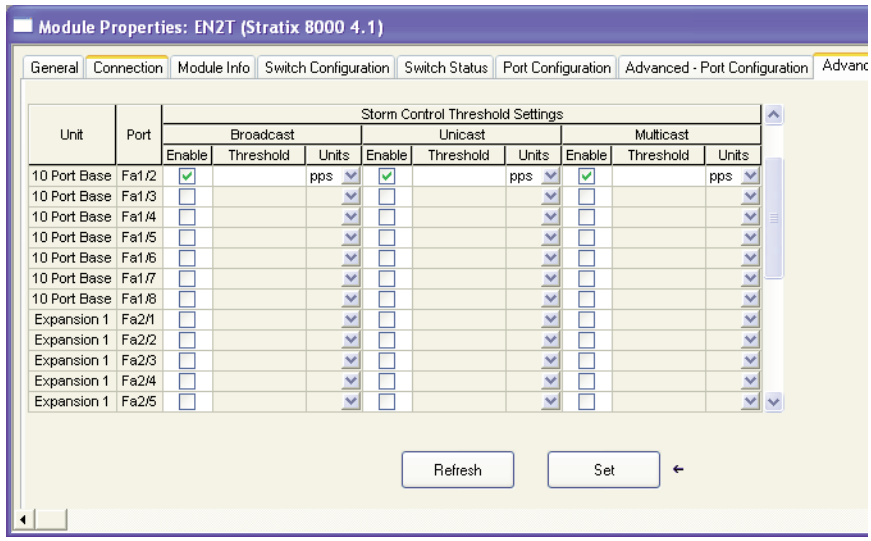
Smartports optimize the port configuration for the device connected to that port. Automation Device is the setting used to connect to typical automation products such as controllers, I/O and HMI. VLAN assignments and MAC ID authorization may also be entered, see Figure 11.

Figure 11
Stratix 8000 Profile Advanced Port Configuration Tab



The threshold tab allows configuration of separate broadcast, unicast, and multicast traffic limits on a port by port basis, see Figure 12.

Figure 12
Stratix 8000 Profile Threshold Configuration Tab



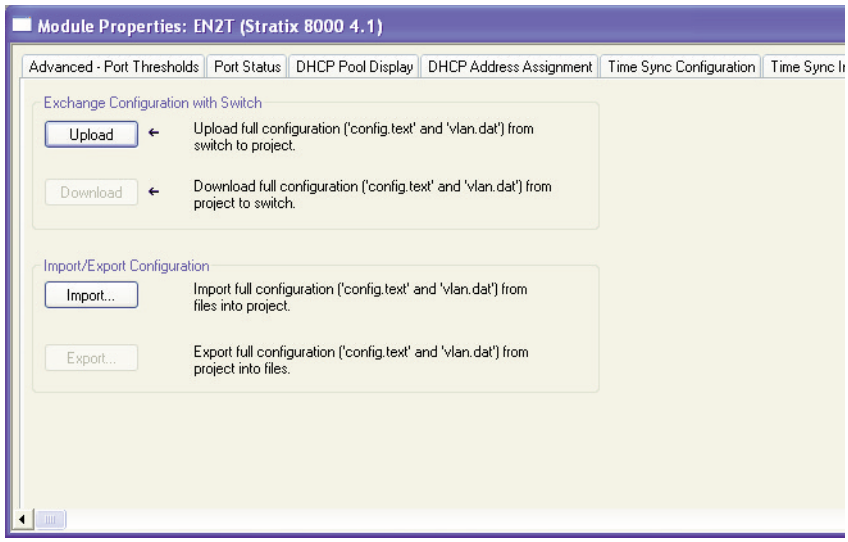
Save and Restore Stratix Switch Configuration

A key differentiator of the Stratix managed switches is the ability to save and restore the switch configuration in the Logix controller and as part of a Logix 5000 project, see Figure 13.

- Selecting Upload from the wizard reads the Stratix 8000 configuration into the project and transfers it to the Logix PAC memory.
- Selecting Save from the RSLogix 5000 menu then stores all configuration settings within the Stratix 8000 switch as part of the RSLogix 5000 project file .
- Selecting Download retrieves the Stratix 8000 configuration from the RSLogix 5000 project file and transfers it to the compact flash card on the Stratix 8000.

- Import and Export provide mechanisms to move the native switch configuration files between the RSLogix 5000 project file and the PC hard drive. This allows users to quickly reuse tested and validated Stratix 8000 configurations across multiple projects. This permits utilizing existing assets (tested and validated configuration) to minimize commissioning of new applications, which helps reduce total cost of ownership.

Figure 13
Stratix 8000 profile Save and Restore Tab


Module Properties: EN2T (Stratix 8000 4.1)
Advanced - Port Thresholds
Port Status
DHCP Pool Display
DHCP Address Assignment
Time Sync Configuration
Exchange Configuration with Switch
Upload
Upload full configuration ('config.text' and 'vlan.dat') from switch to project.
Download
Download full configuration ('config.text' and 'vlan.dat') from project to switch.
Import/Export Configuration
Import...
Import full configuration ('config.text' and 'vlan.dat') from files into project.
Export...
Export full configuration ('config.text' and 'vlan.dat') from project into files.

Stratix Switch Status

The Stratix 8000 AOP provides a number of tabs to view the switch and related network status, diagnostics and alarms. During commissioning and operation of the switch or network, these status and diagnostics allow first-level diagnostics and troubleshooting for maintenance and operations.

Stratix switch information includes:

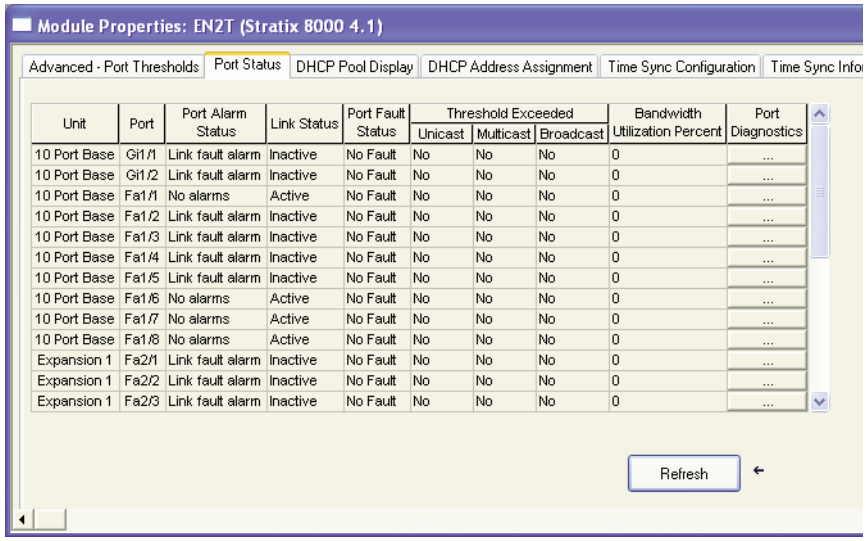
- Switch hardware configuration
- Serial numbers
- Revision levels
- Connection type

Status and Alarms include:

- Major and minor alarm relays
- Switch uptime
- Switch temperature
- Port alarm status
- Link status
- Port fault status
- Thresholds exceeded
- Bandwidth utilization
- Detailed port traffic diagnostics

For example, if a threshold limit is exceeded, network traffic for that type will be dropped on that port until the traffic falls below the set limit for that port. Additionally, the corresponding I/O data tag will alert the Logix PAC and the threshold parameter in the port status tab in RSLogix 5000 will be set, see Figure 14.

Figure 14
Stratix 8000 Profile
Port Status Tab


Module Properties: EN2T (Stratix 8000 4.1)
Advanced - Port Thresholds
Port Status
DHCP Pool Display
DHCP Address Assignment
Time Sync Configuration
Time Sync Info
Unit
Port
Port Alarm Status
Link Status
Port Fault Status
Threshold Exceeded
Unicast
Multicast
Broadcast
Bandwidth Utilization Percent
Port Diagnostics
10 Port Base Gi1/1 Link fault alarm Inactive No Fault No No No 0 ...
10 Port Base Gi1/2 Link fault alarm Inactive No Fault No No No 0 ...
10 Port Base Fa1/1 No alarms Active No Fault No No No 0 ...
10 Port Base Fa1/2 Link fault alarm Inactive No Fault No No No 0 ...
10 Port Base Fa1/3 Link fault alarm Inactive No Fault No No No 0 ...
10 Port Base Fa1/4 Link fault alarm Inactive No Fault No No No 0 ...
10 Port Base Fa1/5 Link fault alarm Inactive No Fault No No No 0 ...
10 Port Base Fa1/6 No alarms Active No Fault No No No 0 ...
10 Port Base Fa1/7 No alarms Active No Fault No No No 0 ...
10 Port Base Fa1/8 No alarms Active No Fault No No No 0 ...
Expansion 1 Fa2/1 Link fault alarm Inactive No Fault No No No 0 ...
Expansion 1 Fa2/2 Link fault alarm Inactive No Fault No No No 0 ...
Expansion 1 Fa2/3 Link fault alarm Inactive No Fault No No No 0 ...
Refresh

The port status screen provides a quick summary of switch operating state and access to port diagnostic counters. For more information on the capability of the Stratix 8000 family of switches see Reference 12 and 13.

FactoryTalk View Faceplates

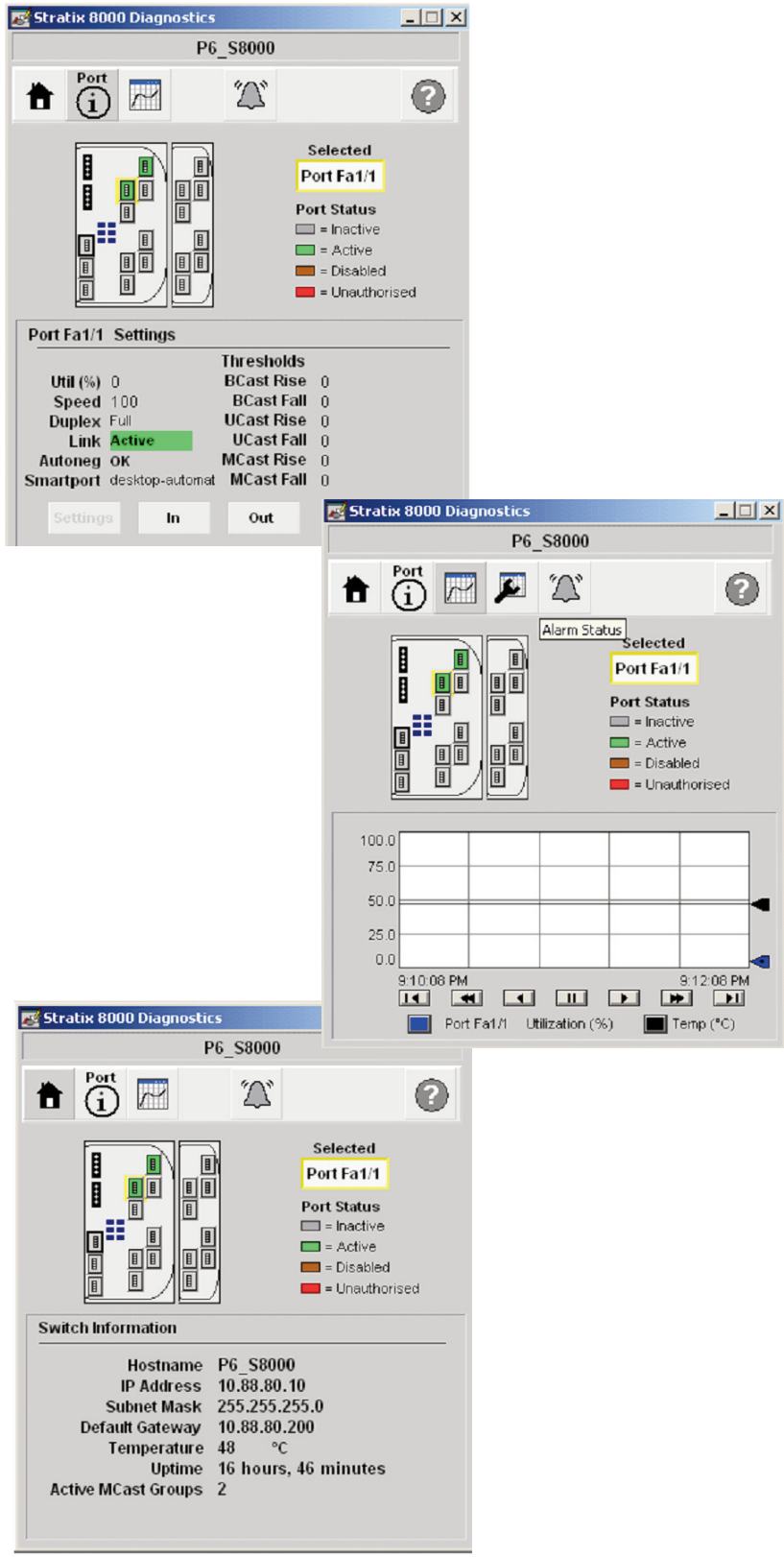
The Stratix 8000 faceplates are a pre-configured HMI application that display diagnostic information from the Stratix 8000 switch in a FactoryTalk View project.

This fuctionality consists of two components; an Add-on Instruction (AOI) which integrates into a Logix controller program and a global display object used in the FactoryTalk View project. The faceplates can be used with FactoryTalk View SE (Site Edition), FactoryTalk View ME (Machine Edition), or PanelView Plus operator interface. The information available from the faceplates is summarized below with a few sample display screens shown in Figure 15:

- Stratix Information
- Individual Port Status
- Individual Port Fault Status
- Display Diagnostic Information on a per-Port Basis
- Trend of Port Utilization and Temperature of Stratix vs. Time
- Enable/Disable of each Stratix switch Port

The selection bar across the top allows navigation between the six different faceplate templates. Faceplates can be used as is or modified by the user to meet specific application requirements. For more information and where to obtain the faceplates see Reference 14.

Figure 15
Stratix 8000
Sample FactoryTalk View
Faceplates



Summary

The converged Ethernet model introduces active components, specifically switches, into the manufacturing network infrastructure. These active components traditionally required separate management tools and have not been integrated into the control system itself. This disconnect from the control system can lead to higher asset management costs, longer mean time to repair (MTTR) and lower overall equipment effectiveness (OEE), which undermines the business drivers that drove the convergence of Ethernet in the first place.

The Rockwell Automation Stratix industrial Ethernet switches provide the functionality and toolsets that facilitate network convergence, whether it's the convergence of islands of automation into an integrated plantwide control and information network or convergence of manufacturing and enterprise networks.

The Stratix 6000 and Stratix 8000 portfolio addresses these through:

- **Common Tools** – supported by familiar Rockwell Automation software tools, reducing training requirements thus maximizing human assets.
- **Ease of Use** – RSLogix 5000 programming software tool used to configure Logix PACs and the Stratix switches.
- **Maintainability** – tags are automatically created in Logix PACs for Stratix 6000 and 8000 status and diagnostics, thus available to FactoryTalk View diagnostic Faceplates for use by maintenance and operations.
- **Manageability** – Stratix swithces configurations are stored as part of the RSLogix 5000 project file.

Additional Reference Material:

1) Reference Architectures for Manufacturing Whitepaper
   http://www.ab.com/networks/architectures.html
2) The Rockwell Automation Integrated Architecture
   http://www.rockwellautomation.com/solutions/integratedarchitecture
3) EtherNet/IP
   http://www.ab.com/networks/ethernet.html
4) Stratix Portfolio of Industrial Ethernet Products
   http://www.ab.com/networks/switches
5) ODVA
   http://www.odva.org
6) Securing Manufacturing Computing and Controller Assets Whitepaper
   http://www.ab.com/networks/architectures.html
7) Production Software within Manufacturing Reference Architectures Whitepaper http://www.ab.com/networks/architectures.html

8) Achieving Secure, Remote Access to Plant-Floor Applications and Data Whitepaper http://www.ab.com/networks/architectures.html

9) Rockwell Automation Network and Security Services http://www.rockwellautomation.com/services/security

10) Stratix 8000 EDS File Download Site http://www.rockwellautomation.com/resources/eds

11) Rockwell Automation Knowledgebase http://www.rockwellautomation.com/knowledgebase

12) Stratix 8000 and 8300 Ethernet Managed Switches Installation Instructions – 1783-IN005 http://www.rockwellautomation.com/literature

13) Stratix 8000 and 8300 Ethernet Managed Switches User Manual – 1783-UM002 http://www.rockwellautomation.com/literature

14) Stratix 8000 Factory Talk View Faceplates and Logix AOI toolkit in the Sample Code Library http://www.rockwellautomation.com/support/downloads.html

FactoryTalk, FactoryTalk Services Platform , FactoryTalk Security, FactoryTalk Directory, FactoryTalk Diagnostics , FactoryTalk Live Data, FactoryTalk Alarms and Events, Factory Talk View SE, FactoryTalk AssetCentre, FactoryTalk Transaction Manager, RSLinx Enterprise, RSLogix, RSNetWorx, RSLogix Architect are registered trademark of Rockwell Automation, Inc.

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